VI. *On the Pairing of the* Plebeiid *Blue Butterflies* (Lycaeninae, tribe Plebeiidi). By T. A. Chapman, M.D., F.Z.S.

[Read March 1st, 1916.]

Plates XVIII–LXII.

In the following notes I propose to describe some specialisations of both the male and female appendages in the tribe *Plebeiidi* of the "Blues" (Lycaeninae).

Much has been done in the description of the male appendages of the Lepidoptera, both from a morphological and a systematic point of view, though not perhaps much as compared with what remains to do. The female appendages have been less elucidated, and the precise correlation of the male and female appendages has barely been dealt with.

My observations refer to the latter aspect of the subject in a small tribe of the "Blue" butterflies, in which the specialisations seem at first sight quite paradoxical when compared with what is usual in the rest of the order. A few years ago on comparing notes with my friend the Rev. C. R. N. Burrows, it appeared that he had noted that there was something unusual in the pairing of these butterflies, and it is very probable that, like us, others were, broadly speaking, cognisant of this circumstance; but I have not met with any published account of the facts either generally or in detail.

It may be arguing in a circle, but I incline to define the *Plebeiidi*, as those butterflies that possess this particular specialisation, and to assert that it does not exist outside the tribe. This, however, will not seem so irrational, in view of the fact that, with small specific variations, the structures throughout the tribe are very uniform, and that outside it there is a considerable gap between it and the nearest approach to it amongst related tribes.

The "Blue" butterflies (the sub-family Lycaeninae) comprise a number of tribes; the one we are interested in, the Plebeiidi, is especially a Palaearctic (and Nearctic) one. For example, of the eleven Blues accredited to our British

list, six are Plebeiids, and of the other five, two, *argiades* and *boetica*, can hardly be called natives. Of European species there are nearly three Plebeiids to two of other tribes, and the same is about the ratio in the whole Palaearctic area. So far as my knowledge extends, no PLEBEIIDI are found south of the Palaearctic (and Nearctic) region, except the genus *Chilades*, a genus less typical of the tribe than any other. This is quite subtropical, if not tropical, in its distribution; (*Polyommatus*?) *martini* and *allardii*, occurring in Algeria though not in Europe, seem to be the most southern of typical species, but are always tabulated as Palaearctic.

I have no systematic objects, but shall for convenience adopt the genera given in Tutt's "British Lepidoptera."

The male appendages of the Plebeiids are remarkably similar throughout the tribe, both in the form and character of the clasps and of the dorsal armature, and differ very much from those of other "blues" in these structures. These are so frequently figured in papers of my own in our Transactions, in Tutt's "British Lepidoptera" and elsewhere, and by others, that I need not dilate on them.

Before describing the actual structural peculiarities of the Plebeiids, that bear most directly on the subject of this paper, it may be useful, as some basis of comparison, to say a few words as to what, so far as my meagre knowledge permits, is the most usual structure of these parts that obtains in other Lepidoptera, or rather to indicate something of the range of variation that obtains in those portions of the appendages that in the Plebeiids are at the extremity of the range in a certain direction.

The most characteristically specialised of these in the Plebeiids is the penis, which has to reach the bursa and provide it with the product of the male glands.

The penis consists usually of two portions—the aedeagus, a solid, basal, highly chitinised portion, and the eversible membrane (*vesica*, Pierce); the latter often armed with spines, etc. (*cuneus*, Stitz, *cornuti*, Pierce).

When pairing takes place the *bursa copulatrix* is reached either by the aedeagus, or by the extension of it constituting the eversible membrane.

A conclusion one early arrives at in examining these structures is that the aedeagus and the eversible membrane are continuous portions of one structure (or tube), as is,

of course, obvious when the membrane is everted; but beyond this, that the external portion of the aedeagus only differs from the membrane by being chitinised, and that the length of the external portion of the aedeagus varying in different species, and often greatly in closely

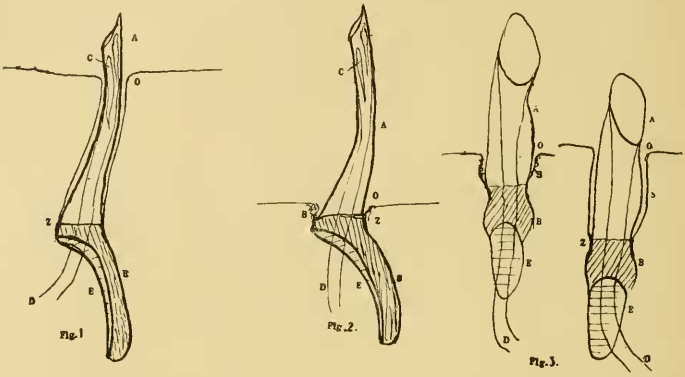

Fig. 1.—Diagram of aedeagus (founded on *Thecla*) when retracted.

Fig. 2.—Diagram of aedeagus when exserted.

Fig. 3.—Similar diagrams of aedeagus in an *Erebia*. The lettering indicates :—

A. Chitinous tube of the aedeagus, external portion.

O. The opening in the floor of the genital cavity, through which the aedeagus is advanced and retracted.

S. Membranous sheath, sinus (Kusnezov), derived from floor of cavity, that permits this movement, stretched in fig. 1 during retraction, gathered together in fig. 2.

Z. The zone at which *S* is attached to the aedeagus.

B. Internal portion of aedeagus continuous with *A*, but having an outer layer continuous with *S*.

E. Internal opening of aedeagus, where the two layers are reflected into each other.

D. *Ductus ejaculatorius*, continuing upwards into *A*, and reflected from it at its free margin, *i. e.* continuous with it, forming in this region the eversible membrane (*vesica*, Pierce) armed with *C* (*cuneus, cornuti*).

The same explanations apply to fig. 3, which gives advanced and retracted positions of the aedeagus.

allied species, does not depend altogether on a greater or less development of a special portion of the aedeagus, viz. that beyond the zone, but in the greater or less extent of the *azygos* (Sharp) tube that is chitinised to become aedeagus or remains membranous as eversible membrane.

I have, for convenience, applied the name *zone* to that line where the internal and external portions of the aedeagus meet, a line by which the aedeagus is attached to the floor of the genital cavity—the circumstance which renders the outer portion "external" and the inner one "internal." I shall return immediately to a fuller discussion of the zone, since it is of importance in the homologies and morphology of the aedeagus, and an important item in the specialisation of the Plebeiid aedeagus.

In most Lepidoptera the aedeagus is more or less retractile, or, conversely, one may say exsertible. In text fig. 1, a diagrammatic view of the aedeagus in *Thecla*, only a small portion of the aedeagus projects beyond the floor of the genital cavity when the parts are at rest, the greater part is retracted into a membranous tube (*sinus* *) extending from the opening in the floor of the genital hollow to the zone. In action the aedeagus can be exserted as in fig. 2, the tube in which it rested being shortened and its walls gathered together.

The external portion of the aedeagus, that beyond the zone, is almost evidently a portion of the azygos tube, or ductus, everted and chitinised; but the internal portion, that is, that that is basal to the zone, consists not of a simple internal prolongation of the external portion, but has also fused to its external surface a prolongation of the sheathing tube, these being reflected into each other at the internal aperture of the aedeagus. This interpretation of the actual structure is so nearly self-evident, that it seems in the highest degree likely to be correct. But a further speculation as to which is the point at which the floor of the genital cavity meets the extremity of the ductus has very few data on which to reach a conclusion. Is it the zone, is it the internal opening of the aedeagus, or is it the external opening of the membranous sheath? There is here a possibility of confusion from the use of the term sheath; penis-sheath has been used as a name for the aedeagus, and penis-sheath (*penis-tasche*) has been the name applied to structures of the floor of the genital cavity surrounding the opening of what I have called the membranous sheath (sinus). There is in the Plebeiids no penis-sheath as a structure immediately surrounding the aedeagus.

There is one fact that goes a long way to show, one

* I find this term used by Kusnezov, whether on his own or some other authority, I don't know.

may say to prove, that the membranous sheath (sinus) is not a portion of the ductus, but is an invagination of the floor of the genital cavity.* In many cases, I cannot say in a majority, still less in all cases, though it may be so, the sheath has a sparse armament of hairs, such as are only found on external cutaneous surfaces, whence it follows that it must be a portion of the surface of the 9th or 10th abdominal segment, or possibly of the membrane between them; the latter is very unlikely. My own opinion is that it belongs to the 10th abdominal segment, and that the opening of the ductus in the male corresponds to that of the oviduct in the female on that segment. There is never any trace of a hair or hairlike structure on the aedeagus itself; the aedeagus is therefore an internal structure (a portion of the ductus). It is hardly necessary to say that the cornuti are not in any way hairs, though some of their forms are very similar to some forms of hairs.

I was for long ignorant of this armament of hairs on the membranous sheath, due no doubt to several reasons; that they are often absent is probably one. If one removes the aedeagus from the rest of the appendages, it is apt to be separated at the zone, and the sheath is not seen with it, and when examining the parts undisturbed the hairs are obscured behind other parts, and, if seen, it is not at all clear what their origin is. Nevertheless, when one is aware of their existence, it is often possible to make them out satisfactorily. In Pl. XXIII are two specimens of the aedeagus of *Curetis bulis*; on one of them the sheath is left uninjured, on the other only a portion of it remains. The hairs on the sheath are in this instance very obvious.

The wall of the internal portion of the aedeagus is not a simple internal chitinous structure, but arises from the fusion of two layers, which we may for the moment assume to be an outer one belonging to the general surface, an inner derived from the azygos tube; the fusion being, of course, of their opposed outer surfaces. It would, however, equally meet the case if both the layers were of the external surface, or both of the azygos tube. The reflection from the one layer to the other occurs at the opening in the base of the aedeagus, frequently placed some way from the extremity through which the azygos tube (" eversible

* Diaphragm is a term that has been applied to the membrane forming this floor.

membrane," *vesica*) passes from the visceral cavity into the interior of the aedeagus.

We may assume the initial structure to be a membranous tube opening on the surface (between segment 9 and 10 ventrally). A portion of this tube remains more or less in its primary condition as the *ductus ejaculatorius* (Auct.). Beyond this is the eversible membrane, which in some species barely exists, the extremity of the aedeagus reaching the bursa; in other species, those on which our usual conception of it is formed, it is contained within the aedeagus. There are, however, many species in which it is of great length and extends back beyond the aedeagus into the abdominal cavity, and except that it is eversible and usually armed with cornuti, it might be regarded as a portion of the *ductus ejaculatorius*. The eversible membrane is, in fact, a portion of the ductus. Beyond this I regard the external portion of the aedeagus as simply a portion of the same duct, permanently everted and chitinised. The internal portion of the aedeagus, as I have said above, being a double inversion from the margin of the original orifice.

What one may call the usual or average length of the extrusible portion of the aedeagus is somewhere probably between that in *Thecla*, illustrated in fig. 1 on Pl. XVIII and XIX, and that in *Melitaea*, Pl. XXI.

There are not a few cases and whole groups in which the aedeagus is much longer than this, as, for instance, in *Apatura*, and very markedly in many species of *Acraea* (Eltringham, Trans. Ent. Soc. 1912, Pl. XI–XII); in a whole group of *Tineae* (Bankes, E.M.M. 1910, Pl. V. and 1912, Pl. IV). See Pl. XXII. In all these cases of great length in the aedeagus, there is a corresponding lengthening of the saccus, no doubt to give a proper origin to the retracting muscles.

In fig. 4 I have (with *Thecla* as a basis) made a diagram of an arrangement which one would suppose possible, and which for all I know may actually occur, but which I believe does not exist, and of which I have met with no trace in any preparation I have examined, though it is possible by undue violence to cause the membranous sheath to be more or less everted. It is supposed to show that the aedeagus might be advanced by the eversion of the sheath by a length approximate to that for which it provides a retreat. I don't know of any case in which

the zone rises above the floor of the cavity. My observations are, of course, meagre, and this opinion can only go for what it may be worth.

The same proviso probably applies, though not quite as strongly, as the observations are more definite in character, to my statement that the reverse condition, found in the Plebeiid Blues, does not occur elsewhere.

If we follow the surface from the genital hollow to the interior of the ductus (*azygos*, Sharp) we first reach the opening of the membranous sheath; continuing down this, we reach the zone; here the membrane of the sheath becomes attached to the external surface of the aedeagus, and seems clearly to be an addition to it—that is, the

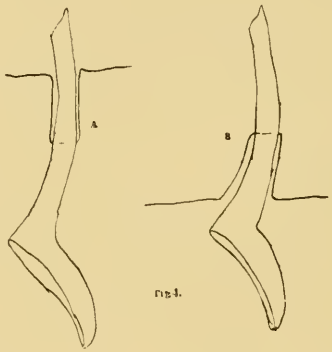

Fig. 4.—Suggests that the aedeagus might be advanced by the eversion of the membranous sheath; this does not, apparently, in fact, ever occur.

aedeagus here becomes suddenly thicker and denser, and the membranous sheath has all the appearance in most cases of being the outer layer of this portion of the aedeagus set free from the inner; a little further on, however, they seem to be completely fused. Following them on, assuming however, that we are following the outer layer, we arrive at the internal opening of the aedeagus, where the one layer is reflected into the other; and now returning on our journey, but following the inner layer, we arrive again at the zone and pass on to the free external portion of the aedeagus, and reaching its extremity, return down its interior, along the ductus proper, in which there is no definite line of demarcation between the eversible portion

(*vesica*, Pierce) and the more internal portion which is never everted.

In some species with longer external portions to the aedeagus (as in *Thecla*) there is, strictly speaking, no eversible membrane, the extremity of the aedeagus appears to reach the bursa and there expands, by the spreading

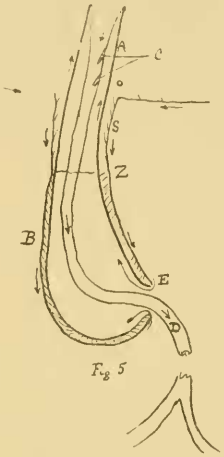

Fig. 5.—A diagram to show the continuity of the azygos duct with the cutaneous surface (floor of genital cavity). The arrows indicate the route from the external surface by way of the membranous sheath (sinus *), the surface so far, often bearing hairs, to the zone, thence, fused to its returning layer, to the internal opening of the aedeagus and back again, continuing then as the external portion of the shaft of the aedeagus, and at its extremity returning as eversible membrane and ductus.

of portions of its extremity and stretching of the adjacent membrane; this membrane and the movable portions at the extremity of the aedeagus are, however, no doubt, homologous with the eversible membrane and cuneus (*cornuti*, Pierce).

* Zander, Zeitsh. fur. Wiss. Zool. 1903, applies the term *penis-tasche* to the sleeve for which I have accepted the name *sinus*, but extends the said *penis-tasche* not only to the base of the aedeagus but right away beyond the aedeagus along the *ductus ejaculatorius*, where it is quite free from the aedeagus in the abdominal cavity. He uses *ringwall* for the armature that often surrounds the aedeagus on the floor of the genital cavity (diaphragm), and which other authorities call *penis-tasche*.

There can, it seems, be no doubt that the membranous sheath of the aedeagus is a portion of the external surface, probably of the 10th abdominal segment, and still more certainly that the free (external) portion of the aedeagus is of internal origin, *i. e.* a portion of the azygos duct. The internal portion, consisting of two fused layers, may present material for doubt, but the doubt has no particular bearing on the subject of this communication, though of morphological interest and suggesting further investigations.

For my own part I incline to the opinion that the zone represents the circle of the original opening of the ductus on the surface, and that the aedeagus consists of reflections and invaginations of the ductus only, without any surface structures being incorporated.

The period before the evolution of the aedeagus, when the ductus opened simply on the surface must be very remote, certainly before the Lepidoptera originated, possibly antecedent to the Insecta.

Whenever it may have been, the date was so ancient that one is astonished to find the aedeagus and ductus still so plastic, and capable of so rapidly (as between two closely related species) changing their form. No doubt the selection that evolved species also insisted throughout on the plasticity of these structures, without which new species would frequently have failed to establish themselves; since a fixity of structure, such as is usual in most other portions of the organism, would easily have led to syngamic absorption of the new species before its segregation was sufficiently prolonged to give real specific separation. In other words, a species in which these organs refused to vary, would on meeting with an incipient species derived from it simply absorb it, *i. e.* it could not meet new conditions by offsets of new species, and could only vary *en masse*, and would be very likely to become extinct. The incipient species could not avoid absorption unless its segregation (in whatever way) had been sufficiently prolonged to make it no longer incipient.

It is difficult to suppose, in the case of such groups as our Plebeiidi, that segregation could often have been so prolonged, so many of the species having such similar habits and habitats.

In the Plebeiids, the relation of the aedeagus to the genital cavity is reduced to its simplest elements. The floor of the cavity is a simple smooth screen, reaching from

the dorsal armature above to the margin of the ring and bases of the clasps below, pierced by the anal aperture and by the aedeagus, without any trace of scaphium or any anal armament, no *gnathos* and no sinus or armament of any sort round the aedeagus.

The aedeagus is thus held practically in one spot, with no antero-posterior movement, and only some possibility of varying in direction, considerable in the separated parts on a slide, but probably little or nothing in the living animal. Besides this fixity the Plebeiid aedeagus has another peculiarity—the free portion, that beyond the zone, is extremely short. This is most extreme in the genera *Polyommatus* and *Agriades*, apparently least so in *Plebeius*

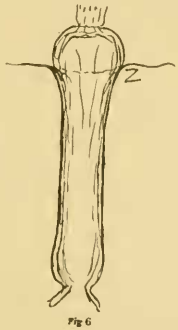

Fig. 6.—Diagram of aedeagus of *Agriades bellargus*, showing absence of sinus and brevity of free extremity.

(*aegon*) and *Aricia* (*astrarche*), in which there is a considerable external portion, chitinous, however, only on one aspect, in which it ends in a point; the other aspect is membranous (eversible), reaching up, in a sharp angle, close to the zone. (Pls. XXVII, XXVIII, XXIX, also see figs. 1 and 4, Pl. V, p. 101, Ent. Rec., vol. xxii.)

One must, therefore, take this prolongation to be merely the extremity and not part of the shaft. The peculiar specialisations of the male appendages in the Plebeiids appear to be, as regards the aedeagus, its fixity by the zone being in the floor of the genital cavity without any sinus, and probably its fixity in direction also, during life, however much it may appear movable on a slide; its position close under the dorsal armature, and its separation from the clasps by a large smooth area of the floor of the

genital cavity, and the extreme shortness of the free portion of its shaft beyond the zone. These limitations prevent it making any approach to the female parts during pairing, a defect that is made good by the specialisation of the female, enabling the approach to be made by the female and not by the male. The great uniformity of the clasps in the group is no doubt related to this female specialisation; the fairly uniform dorsal armature has also, no doubt, some special correlated relationship, possibly with the extremity of the ovipositor, but as to this I can make no definite suggestion.

The figures given of the male genitalia and of the aedeagus separately are more specially referred to in the "Explanations of Plates," and need not be detailed again here. As to the Plates, it seemed desirable to restrict their number, else one would have desired to give figures—of a larger number, if not of all the species of the tribe—of both the male and female structures.

As regards the corresponding female structures, there is in the *Plebeiidi*, apparently, an even greater departure from the normal structure than obtains in those of the male.

Considering for a moment the more usual form of these parts we find that in species where the aedeagus is long, it is usual for the cervix * to be long also, and to be, moreover, often chitinised into a solid tube for some distance. This may be seen in many Theclas (*e.g.* Pl. XVIII and XIX), in *Apatura* (Pl. XXIII), and in a less degree in many species in which the aedeagus is of average length. In the case of *Acraea natalica* (Pl. XXII), with a very long aedeagus there is also a very long cervix, but it is not very solidly chitinised, and in the photograph it will be seen to have twisted somewhat in the specimen, possibly from having been too much macerated.

It leads to another subject, with which I am not at present anxious to deal—namely, the segmentation of the abdomen in the females of Lepidoptera, but it may often be observed that the ostium is withdrawn (not invaginated) within the margin of the 7th abdominal segment, as may, for example, be observed in Scoparia (see Trans. Ent. Soc. Lond. 1911, Pl. XXXV, et seq.); in these cases there is generally no armature. When the ostium has an armature, it generally remains outside the 7th segment.

* Cervix, or ductus, the duct between the *ostium* (external opening) and the *bursa copulatrix*.

In most of these cases the ostium and its armature, if any, is all that there is to represent the 8th abdominal segment. Nor, indeed, is there often any chitinous plate to represent either the 9th or the 10th abdominal sternites.

In all cases (" all " must be understood to mean merely within my observations and experience) in which the ostium is within the margin of the 7th segment, it appears to be the outer end of a chitinous cervical tube (Pl. XVIII and XIX).

When there is any armature it appears to fix the ostium more or less just outside the margin of the 7th segment (Pl. XXI and XXII, fig. 2).

The peculiarity in the Plebeiids is that the ostium is carried by a small chitinous plate; but there is a special extensible structure by which this plate may be extruded as far or further than the end of the ovipositor.

When at rest the plate occupies the usual position of the ostium, viz. at the margin of the 7th segment, but behind it is the apparatus for its projection.

In Pl. XXXI the parts are shown as they are when at rest. In Pl. XLII they are seen partially extruded. In the majority of the figures they are shown fully extruded, or as nearly so as is easily obtainable in making the preparations.

It is seen that the small terminal plate is carried at the end of a long membranous tube, when this is extended, and the appearance at first sight suggests that the function of the eversible membrane of the aedeagus has somehow been transferred to the female structures. This is, of course, absurd; its real function is to carry the ostial plate to the fundus of the male genital cavity so that it may meet the very short and immovable aedeagus. A function almost as surprising as the impossible one mentioned, and, so far as I know, without any parallel amongst other Lepidoptera.

This eversible structure consists of two portions—the outer one, that is often simply membranous, but carrying the terminal plate, and an inner one, that is reversed by invagination when it is retracted, and which is strengthened by a loop of chitin; this may be seen in the Pl. XXXI to XLVII.

I have named these two portions, the inner the " prop " (*hypostema*), and the outer the " rein " (*henia*). (By a misprint in Trans. City of London Ent. Soc. *heina*.)

In evagination the prop begins the eversion at its outer margin; phases in the process may be noted in various of the Plates, as *e. g.* XXXII, fig. 1; XL, fig. 2; XLI, fig. 1; XLVIII, fig. 2.

Within the rein may usually be easily seen the cervix (Stitz), passing backwards from the terminal plate to the *bursa copulatrix*; it is sometimes possible by traction basad on the bursa to withdraw the rein within the prop, which at the same time, of course, invaginates; the opportunity to do this often occurs in preparing the specimens.

What are these eversible structures, the prop and the rein? What segments do they belong to, and what parts of the segments are they? I have been able to discover only one detail in their structure that seems to throw any light on this. The membranous surface of the basal portion, the prop, is apparently simple and free from any cutaneous structures such as hairs, skin-points, etc. The rein, however, is regularly studded with points that have all the appearance of abortive hairs or scales, *i. e.* they are something more than mere skin-points, though if they were the latter their significance would be the same.

The membrane forming the tube of the rein must therefore be a portion of the sternite of the 8th abdominal segment, that of the prop a portion of the membrane between the 7th and 8th segments. The chitinous loop in the prop is possibly not easy to explain on this hypothesis, but its explanation on any other seems equally difficult.

The terminal chitinous plate containing the ostium is surrounded by the hair-point-studded tube, *i. e.* by the surface of the 8th abdominal sternite; it must therefore be situated *in* the sternite and not at either margin. This is an interesting conclusion to arrive at, as the usual evanescence of both plates of this segment, in practically nearly (or quite) all other cases, leaves us without any data on this point.

It is a secondary, but useful, circumstance, that each species of Plebeiid butterfly seems to have a distinctive form for the small terminal plate. This appears in most of the photographs presented herewith, though in some cases the smallness of the differences, the occasional variation by the plate not being exactly in the plane of the picture, and the loss of definition in reproducing the photographs, may prevent this being evident.

This is so, as far as I have observed, though I have not prepared long series of specimens in more than two or three species.

The extraordinary extensibility afforded by the prop and rein does not occur, I think, elsewhere; I can, however, rely only on my own small knowledge of these structures, which may easily be at fault. Some other groups of the LYCAENINAE show what we may regard as initial stages of the Plebeiid structure. For example, *Lampides boeticus* (Pl. LV. LVI), which has an immense terminal armature to the ostium extremely unlike anything in the Plebeiids, nevertheless retracts and extends this mass for a distance equal to its own length, as is seen by comparing the photographs on Pl. LVI. *Iolas* (Pl. LIII), again, on the other hand, with an equally large armature, seems to have it much less movable. *L. argiolus* (Pl. LIV) also has the armature slightly movable, but apparently not retractile.

L. alcon and *euphemus* (Pl. LVII) seem to be retractile. *T. telicanus* and *E. argiades* (Pl. XLVIII) are also apparently retractile, but none of these to more than a small amount.

I have put on the same plate as the two last (Pl. XLVIII) a photograph of *P. martini*; this is quite a typical Plebeiid, but in the specimen, the parts are only partially exserted, the prop perhaps one-third extended, and the rein therefore equally enclosed. In this species the rein is chitinised near its extremity, as in the species shown on Pl. LIV, in *zephyrus* (Pl. XLIV), in *meleager* and *admetus* (Pl. XLI), in *pylaon* and *candalus* (Pl. XXXVI). The result is to give the two specimens in Pl. XLVIII—*martini*, fig. 2, and *argiades*, fig. 3—the appearance of being of very closely related structure, which is not really the case.

With this reference to chitinisation of the extremity of the rein, it may be as well to include the circumstance that in other species there is a chitinisation towards its base. This occurs in *C. semiargus* (Pl. XLVI), *A. isaurica* and *donzelii* (Pl. XLV), *A. escheri* (Pl. XL), and to a trifling extent in some others, in which it may or may not be really part of the loop of the prop.

I have frequently observed these structures in the field, when functionally active, and have for several years made efforts to secure specimens preserved for observation and examination in that state, but have always failed, though on several occasions I felt sure up to the last moment that I had succeeded.

In some groups success in this matter is easy, why it should be so difficult here is not quite self-evident. It so happens, however, that in several of my preparations I had so nearly succeeded that they practically demonstrate the conditions almost as satisfactorily as had they been quite successful. They demonstrate that the prop and rein are fully extended, that the terminal plate carrying the ostium reaches the extremity of the fixed aedeagus and is penetrated by the eversible membrane therefrom. In examining living specimens, the two insects seem held together by nothing except the pale slender thread of the prop and rein. How this is held firmly to the aedeagus is not very evident, whether it be merely by the eversible membrane that penetrates the ostium, or whether, as the structure of the extremity of the aedeagus seems to suggest, the terminal plate of the rein is held by certain curved and spring-like processes that are very evident in such species as *pheretes*, *semiargus*, *orbitulus*, etc. The clasps do not seem to be used for prehension, at least at the times when my observations were made. Yet their special structure, very nearly identical throughout the tribe, and different from those of any other Lycaenines, show them to have some important function peculiar to this tribe. It seems that this can hardly be other than to take temporary prehension, by grasping the 7th abdominal segment, at the same time causing or assisting the eversion of the prop and rein.

It may be noted in most of the photographs submitted that these parts are compressed antero-posteriorly and so remain straight, the prop and rein in the same apparent straight line. But in others where they are compressed laterally, of which one of the photographs of *hylas* (Pl. XXXIX) is as good an example as any, there is seen to be a sharp angulation between the prop and rein when they are fully exserted and expanded; the effect of this would be, that the angle would reach the inferior angle of the male genital cavity at the base of the clasps, whence the rein would be of just the length to reach along the floor of the cavity to the extremity of the aedeagus, which in the Plebeiids is fixed close to the dorsal margin of the floor and close under the dorsal armature.

When living specimens are examined, all prehension seems in abeyance except by the rein and aedeagus. Whether this is natural, or a result of inhibition by the

captor's interference, may be doubtful, but there can be little doubt that prehension by the clasps takes place in the first stages of pairing.

There is a very curious fact, that I suppose to be of constant occurrence, though I have not observed it much more than about a dozen times. This is, that at the end of the pairing the rein is surrounded by a cylinder of amorphous material, certainly not scales or any similar structures, whether a secretion by the male or female, I don't know (see Pl. LXI and LXII). It easily slips off and is lost; on Pl. LXI it had left the rein, which retained no evidence of having accommodated so curious an accretion. Whether this ought to be called a *sphragis*, and whether it is homologous with that structure in Papilionids and Nymphalids I cannot say.

Explanation of Plates XVIII–LXII.

Plate XVIII. Appendages of *Thecla spini*.

Fig. 1. ♂, showing free portion of aedeagus to be long and its position close to the clasps, × 25.

Fig. 2. ♀, showing ostium (8) and chitinous duct, corresponding in length to the free portion of the aedeagus leading to the bursa, × 25.

Plate XIX. Appendages of *Thecla pruni*, showing similar parts to Pl. XVIII, × 25.

Plate XX. Appendages of *Selenia illustraria*, ♂ and ♀, showing the chitinised duct to bursa (with a hair passed through it) closely corresponds in width and length to the free portion of the aedeagus, × 25.

Plate XXI. *Melitaea athalia*, showing large external armature of the ostium, and correspondence between the free portion of aedeagus and the duct with hair passed through it to bursa, × 20.

PLATE XXII. FIG. 1. Appendages of male of *M. pallescentella*, shows corresponding length of aedeagus and saccus, and position of aedeagus close to clasps, × 45.

FIG. 2. Appendages of *Acraea natalica*. Aedeagus and saccus both very long. In ♀ the ductus is seen to be very long; it is twisted in the preparation; it is very weakly chitinised, × 5.

PLATE XXIII. FIG. 1. Two specimens of the aedeagus of *Curetis bulis*; in the upper one, the membranous sheath and a small portion of the floor of the genital cavity have been kept with it. The length of the sheath (sinus) corresponds with that of the free portion of the aedeagus, *i. e.* that beyond the zone *Z*. In the lower figure only a portion of the sinus remains, but this is more than usually remains with the aedeagus when it is dragged out for separate examination. The clothing of hairs on the sinus is well seen in both preparations, × 24.

FIG. 2. Female appendages of *apatura* iris. The figures refer to the numbers of the abdominal segments. 8 is opposite the ostium, leading to the long chitinous portion of the ductus, corresponding to the lengthy aedeagus in this species.

MALE APPENDAGES OF PLEBEIIDS.

PLATE XXIV. FIG. 1. *Agriades thetis*, × 45, shows the bulbous-ended aedeagus fixed close to the dorsal armature.

FIG. 4. *Agriades escheri*, shows also the long space between the place where the zone is fixed and the origins of the clasp, whose bases only just appear at bottom of figure, × 30. In both these figures, the preparations being pressed flat, the aedeagus appears to be in the same plane as the ring, instead of nearly at

right angles to it; the zone remains fixed, and on it the aedeagus is rotated to the position shown.

Fig. 2. Aedeagus of *Agriades thersites*, × 40.

Fig. 3. Aedeagus of *Agriades damon*, × 40. These two figures show the swollen end characteristic of *Agriades*, the zone right up on the bulb has attached scraps from the floor of the cavity, the shortness of the portion beyond this is obvious, there is hardly a trace of everted membrane.

Plate XXV. Fig. 1. *P. sieversi*, × 30; 2. *P. hyrcana*, × 30; 3. *C. semiargus*, × 45. These show the dorsal position of the aedeagus, and the zone close to its free extremity.

Plate XXVI. Fig. 1. *A. amanda*, aedeagus, × 40.

Fig. 2. *V. optilete*, aedeagus, × 40.

Fig. 3. *V. optilete*, ♂ appendages, except part of clasps, × 30. These show the zone, with portions of floor membrane attached, the short portion of aedeagus beyond differing in structural detail from that of *Agriades*. Fig. 3 shows very well how the floor membrane attached to the zone is taut enough to restrain any forward movement of the aedeagus; a contrary impression might arise from Fig. 2, where a good deal of floor membrane remains attached, limp and crumpled, being torn loose from its other attachments.

Figures on Pl. XXIV, XXV and XXVI show also the unusual length of flat, smooth (*i. e.* free from any sort of armature) field afforded by the floor of the genital cavity between the aedeagus and the base of the clasps.

Plate XXVII. Fig. 1. ♂ appendages of *Pl. eversmanni*, and Fig. 2 of *Pl. pheres*, × 30. These both show a greater length of aedeagus

beyond the zone, but with oblique opening reaching down to that point, and in the case of *Pl. eversmanni* the preparation happens to show a considerable exsertion of the eversible membrane; this accident is very rare in preparations of Plebeiid appendages.

These figures and those on the two following and other plates illustrate the large area between the aedeagus and clasps, as referred to under Pl. XXVI.

PLATE XXVIII. FIG. 1. Aedeagus of *Pl. aegon*, × 40.
FIG. 2. Aedeagus of *Pl. argyrognomon*, × 40.
FIG. 3. Aedeagus with dorsal armature, etc., of *Pl. argyrognomon*, × 45. These demonstrate the oblique opening of the aedeagus beginning at the zone, and that this external portion is less chitinised than the inner piece, and is of pointed dagger form.

PLATE XXIX. FIG. 1. Aedeagus of *Aricia idas*, × 40.
FIG. 2. Aedeagus of *Albulina pherctes*, × 40.
FIG. 3. Aedeagus of *Aricia medon*, × 40.
FIG. 4. Appendages of *Aricia donzelii*, × 20. These show the long slender, pointed end of the aedeagus, with oblique opening beginning at the zone; in *Aricia* and *Albulina* the genitalia do not support generic differentiation from *Plebeius*.

PLATE XXX. FIG. 1. Male appendages (except clasps) of *P icarus*, × 30.
FIG. 2. Aedeagus of *P. eros*, × 40.
FIG. 3. Aedeagus of *A. coridon*, × 40.
FIG. 4. Aedeagus of *Aricia isaurica*, × 40. In Fig. 3 there is some eversion of the eversible membrane. Fig. 4, *isaurica*, is not a typical *Aricia*, a group to which it appears otherwise to belong.

FEMALE APPENDAGES.

PLATE XXXI. Shows the position of the hypostema (prop) and henia (rein) in the position of repose.

FIG. 1. *Thetis*, shows them in lateral view. Fig. 1 shows that they are within the seventh ventral sternite, and Fig. 2 that they may retreat even to within the sixth. Pl. XLII shows the parts partially extended. Also Pl. XL, Fig. 2. Many figures show not quite complete eversion, as referred to in more detail under Pl. XXXII.

FIG 2. *Coridon*, shows them on ventral view (though the dorsal portion of the preparation is almost in lateral view).

PLATE XXXII. *Aricia eumedon*, × 25. Fig. 1 shows the prop not fully everted; this is often so in my preparations in which the parts are twisted to get an antero-posterior view of them; by holding the prop and rein in a straight line, the prop cannot be fully extended without some twisting or crushing elsewhere. The reason for this is seen in Fig. 2, where the view is lateral and the angle between the rein and prop when fully extended is allowed to obtain. It would appear that the prop is more or less between the clasps, whilst the rein reaches dorsally from their bases along the smooth floor of the ♂ genital cavity to the aedeagus. See Pl. XXXIX and LIV.

PLATE XXXIII. FIG. 1. *A. actis*, × 25.
FIG. 2. *A. coridon*, × 25.

PLATE XXXIV. FIG. 1. *P. icarus*, × 25.
FIG. 2. *A. pheretes*, × 25. These two species have the terminal plate carrying the ostium reduced more than in most other species I have examined; they are, in fact, almost evanescent. See also Pl. XLIII.

PLATE XXXV. FIG. 1. *A. amanda*, × 25.
FIG. 2. *A. hopfferi*, × 25. The black patch on the rein of the latter is a foreign body, probably a group of half-macerated scales.

PLATE XXXVI. FIG. 1. *A. pylaon*, × 25.
FIG. 2. *A. candalus*, × 25. These have unusual chitinisation of the rein. In each specimen there is eversion of the rectum or oviduct.

PLATES XXXVII and XXXVIII. In each plate Fig. 1 is × 25, and Fig. 2 shows the prop, × 50. The small chitinous plate at the base of the rein is seen, but the object of the figures is to show the duct to the *bursa copulatrix* running backwards (backwards should strictly be forwards ! !) from the terminal plate of the rein; this is very distinct on Pl. XXXVII. This duct is seen in several other preparations, but may probably hardly come out very distinctly when the photographs are reproduced. Both specimens are *A. thetis*.

PLATE XXXIX. Two specimens of *A. hylas*, × 25, demonstrating the same point as in Pl. XXXII (*A. eumedon*) and Pl. LIV. The one a dorsal, the other a lateral view.

PLATE XL. FIG. 1. *A. escheri*, × 25.
FIG. 2. *A. damon*, × 25. The duct is well seen in Fig. 2.

PLATE XLI. FIG. 1. *P. meleager*, × 25.
FIG. 2. *A. admetus*, × 25. Distal portion of rein somewhat chitinised in both.

PLATE XLII. FIG. 1. *A. thersites*, × 25.
FIG. 2. *P. eros*, × 25. These show the prop and rein only partially exserted. The eversion begins at the attached end of the prop, the end carrying the rein is the last portion to be reversed.
Compare with Pl. XXXI.

PLATE XLIII. FIG. 1. *Pl. aegon*, × 25.
FIG. 2. *Pl. argyrognomon*, × 25. The latter shows the duct very plainly and also the want of a strong terminal plate. Refer also to Pl. XXXIV.

PLATE XLIV. FIG. 1. *Pl. zephyrus*, × 25.
FIG. 2. *Pl. cleobis*, × 25. Fig. 1 illustrates a circumstance not at present before us, viz. that an egg reaches sometimes the end of the ovipositor, at the death of the butterfly, probably as a detail of dying, and then afterwards matures, but being within the ovipositor cannot emerge. In macerating the specimen the egg and larva is apt to be lost, unless specially looked for; without looking for it I have met with it often enough to believe that it is really a very frequent occurrence.

PLATE XLV. FIG. 1. *Plebeius isaurica*, × 25.
FIG. 2. *Aricia donzelii*, × 25.

PLATE XLVI. FIG. 1. *Aricia medon*, × 25.
FIG. 2. *Cyaniris semiargus*, × 25. The form of the terminal plate in *medon* much resembles that in *Chilades*.

PLATE XLVII. FIG. 1. *L. orbitulus*, × 25.
FIG. 2. *V. optilete*, × 25. These two preparations are badly cleaned of scales, etc.

PLATE XLVIII. FIG. 1. *T. telicanus*, × 25.
FIG. 2. *P. martini*, × 25.
FIG. 3. *E. argiades*, × 25. Fig. 2 is a fairly normal *Polyommatus*, but being only partially expanded—compare with Pl. XXXI and XLII—it has a curious

resemblance to the Everid, *E. argiades* (Fig. 3).

Figs. 1 and 3 illustrate the small amount of eversion (as distinct from mere retraction, which is very frequent in most Lepidopterous Families) that occurs in non-Plebeiid Lycaenines, perhaps more marked than usual in *L. boetica* (Pl. LVI).

PLATE XLIX. *Chilades trochilus*, ♂ and ♀, × 25.

PLATE L. *Chilades cnejus*, ♂ and ♀, × 25.

PLATE LI. *Chilades laius*, ♂ and ♀, × 40.

PLATE LII. *Chilades pandava*, ♂ and ♀, × 40. These are the only species of this genus I happen to know; I illustrate them because they are very interesting as the only tropical group of Plebeiids (that I know of). That CHILADES was Plebeiid, was, I think, first stated by Tutt, on my authority, in Brit. Lep., vol. x, p. 157.

In the ♀♀ the terminal plate is lozenge-shaped (refer Pl. XLVI), this is hardly exceptional, and otherwise the ♀ parts are typically Plebeiid. The ♂♂ are less typical. The hard process of the clasp is long and curved, the dorsal processes and hooks are slender and curiously like each other, and the aedeagus has a more elaborate terminal armature than usual; one supposes this may have some relation to the special form of the terminal plate of the rein. It would perhaps be going beyond the subject of the present paper to discuss the matter of two of these species having long rested in the genus *Catachrysops*, on the ground of their having tails. No other Plebeiids are tailed—still, the question of tails amongst the Blues has had too much weight attached to it. Some species have both tailed and tailless forms; a tailed species or two, therefore, within the tribe of Plebeiidi, which we conceive as tailless, ought not to surprise us, as I admit as to myself it does to some extent. Whatever the subjective conditions may be, it is certain that the four species here noted are congeneric. I have, however, so far as possible avoided, in this paper, systematic questions.

PLATE LIII. *Iolana iolas*, ♂ and ♀, × 25. The ♂ preparation is spread and shows the several parts excellently, but hardly their natural relations to each other. This species gives perhaps the largest ♀ external armature I know of amongst Lycaenines, in that respect resembling *L. boetica*; it appears, however, not to be retractile, not to say eversible; it contrasts well with the Plebeiids. I am unable to refer it to any recognised tribe of Lycaenines.

PLATE LIV. FIG. 1. I am not quite sure of the species; I give the figure as another one illustrating the point brought out in Pl. XXXII and again in Pl. XXXIX.

FIG. 2. *L. argiolus*, another Lycaenine to compare with the Plebeiids; the armature appears to be slightly retractile, but in no degree eversible (as in the prop in Plebeiids).

PLATE LV. FIG. 1. *L. boetica*, ♂, × 35, given as the ♀ is illustrated on next plate.

FIG. 2. *L. prosecusa*, ♀, has a very large armature and seems to be very close to *L. boetica* as regards its retractility (and eversibility as regards its proximate section).

PLATE LVI. *L. boetica*, ♀, × 25.

FIG. 1. Armature extended.

FIG. 2. Armature retracted. The structure here seems almost identical with that in the Plebeiids. In Fig. 1 a "prop" is very evident, but the terminal mass is so large that there is room for little if any rein.

This specimen appears to show that the Plebeiid structure is only an extreme form of what obtains more or less in many Lycaenine tribes.

PLATE LVII. FIG. 1. *Lycaena alcon*, × 25.

FIG. 2. *Lycaena euphemus*, × 25. These appear to be similarly eversible with an invaginable prop, and support the conclusion expressed under Pl. LVI.

The following Plates show efforts to preserve specimens *in cop.*, all of which were more or less failures, yet something is demonstrated.

PLATE LVIII. Shows two preparation of *A. thetis* in which an effort was made to preserve the parts in the natural positions when *in cop.* with small success. To diminish manipulations and undue softening of parts by maceration, the scales were not removed or bleached. This much obscures appearances, and even so Fig. 2 shows that the parts have been twisted in handling, the dorsal side of one sex being in line with the ventral of the other. In both preparations the conjunction of the specimens is, however, still probably intact, though the dark scales prevent this being seen. In neither specimen does the prop (hypostema) appear to be fully extended. In Fig. 2 the rein is seen to include sundry tracheae. In Fig. 1 it is enclosed in the adventitious coating illustrated on Pl. LXI.

PLATE LIX. FIG. 1. *A. thetis*, shows the rein still extended towards the aedeagus, but withdrawn from it.

FIG. 2. *A. thetis*, similar result to Fig. 1.

PLATE LX. FIG. 1. *A. coridon*, × 20.

FIG. 2. *A. thetis*, × 14·5. These separated in preparation and are placed as seen quite arbitrarily; both, however, show the extension of the eversible membrane of the aedeagus, as it is rare to find it in ordinary preparations.

PLATE LXI. All figures, *A. coridon*. Figs. 1 and 2 as in Pl. LX. Fig. 3 shows a remarkable coat, found after pairing. surrounding the rein. Here it has slipped off in preparing specimen. It is by no means always found, why I don't know, in the following.

PLATE LXII. FIG. 2 shows it as found *in situ*, in a specimen of *A. coridon* taken *in cop.*, and Fig. 1 in a specimen of *P. eversmanni* out of the cabinet, so that it is not always got rid of at once.

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